Classification Order of Surface-Confined Intermixing. Nanoscale Pattern Formation on Stepped Crystal Surfaces

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The self-organization phenomena at epitaxial interface hold special attention in contemporary material science. Being relevant to the fundamental physical problem of competing, long-range and short-range atomic interactions in systems with reduced dimensionality, these phenomena have found exacting academic interest [1,2]. Besides this purely academic challenge, the motivation behind the present study relates also to the strong dependence of basic physical properties of electronic devices on the sharpness at atomic level of the interface between materials. On that physical background, the present report deals with two-dimensional (2D) surface alloy formation on stepped or vicinal crystal surfaces [3,4]. In specific temperature range, the high diffusion barrier for direct atomic exchange between adsorbed layer and substrate, completely block 2D intermixing on smooth, step-free surface domains. Hence, in a given energy gap the diffusion takes place exclusively via step terrace mechanism. In such systems, the dynamic competition between energy gained by mixing and substrate strain energy, results in diffusion scenario where adsorbed atoms form alloyed stripes in the vicinity of terrace edges. The stripe width, is step-anisotropy dependent and correlates with the relaxation ability of the terraces in specific direction. This phenomenon, considered as incomplete 2D alloying, opens a way various surface pattern to be configured at different atomic levels on the epitaxial interface. Refining important details of diffusion behavior of adsorbed atoms and accounting for the energy barriers at specific atomic sites (smooth domains, terraces, steps and kinks) located on the crystal surface, the presented model reveals a classification order of surface-confined intermixing: blocked, incomplete and complete [3].

Being in agreement with recent experimental findings, the observed stripe alloy formation can be applied to nanoscale surface design and preparation of regular interface patterns with exotic physical characteristics.

References

1. M. Michailov in: *Computer Simulations Studies in Condensed Matter Physics XVI*, *Springer Series Proc. in Physics*, Eds. D. P. Landau, S. P. Lewis and H. B. Schettler Vol. 95, (Springer Verlag, Heidelberg, 2004)
2. H. Brune, Surf. Sci. Rep. **31**, (1998) 121
3. M. Michailov, Phys. Rev. B **80**, (2009) 035425
4. M. L. Anderson, M. J. D'Amato, P. J. Feibelman, B. S. Swartzentruber, Phys. Rev. Lett. **90**, (2003) 126102